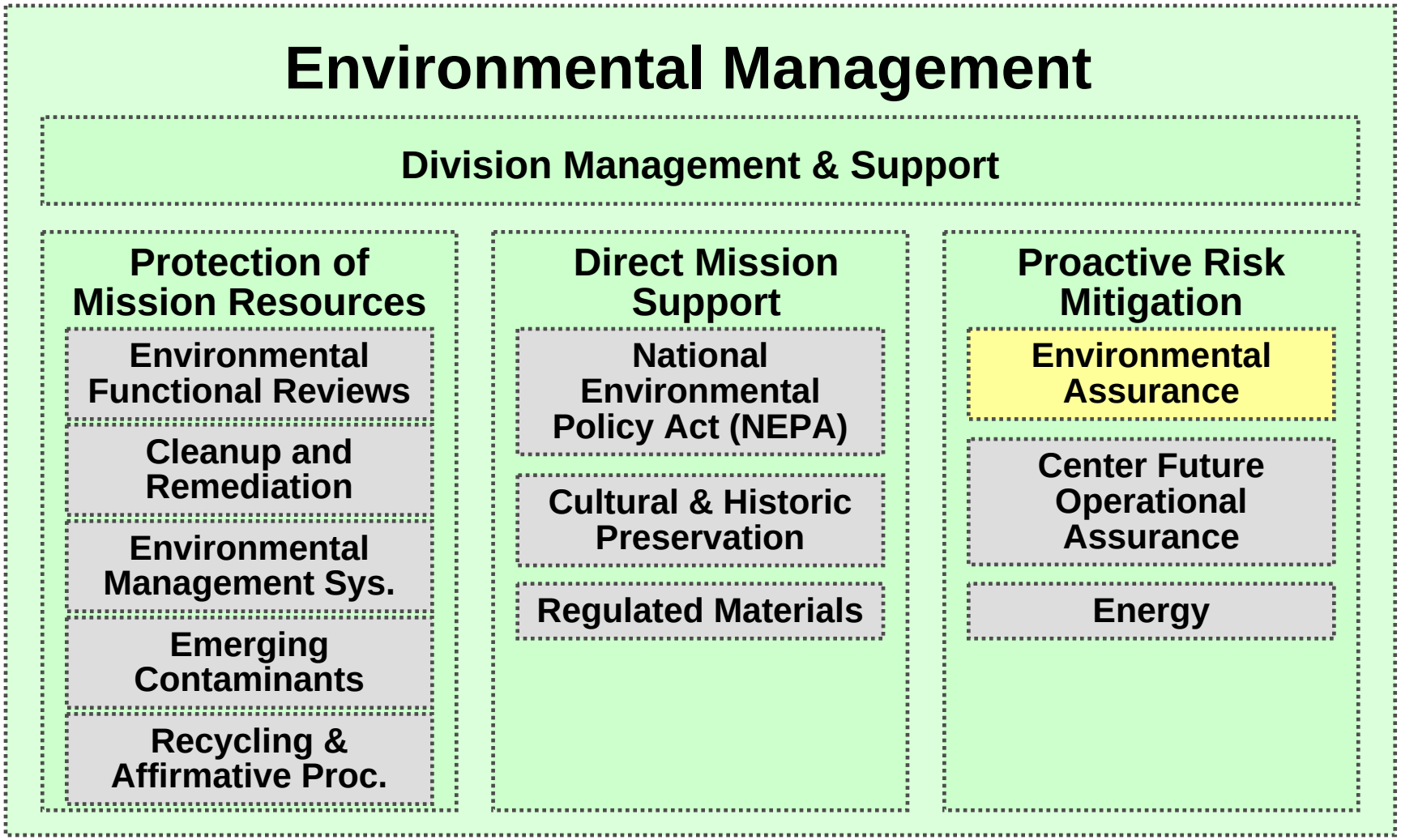
Overview of Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM)

Applied Technology Transfer Office
Kennedy Space Center, FL

Pattie Lewis, NASA TEERM Engineer

Alignment with Mission



Environmental Assurance Definition

Environmental Assurance is the proactive detection, analysis, mitigation, and communication of environmentally driven risks to NASA mission-required research, development, fabrication, processing and operations.

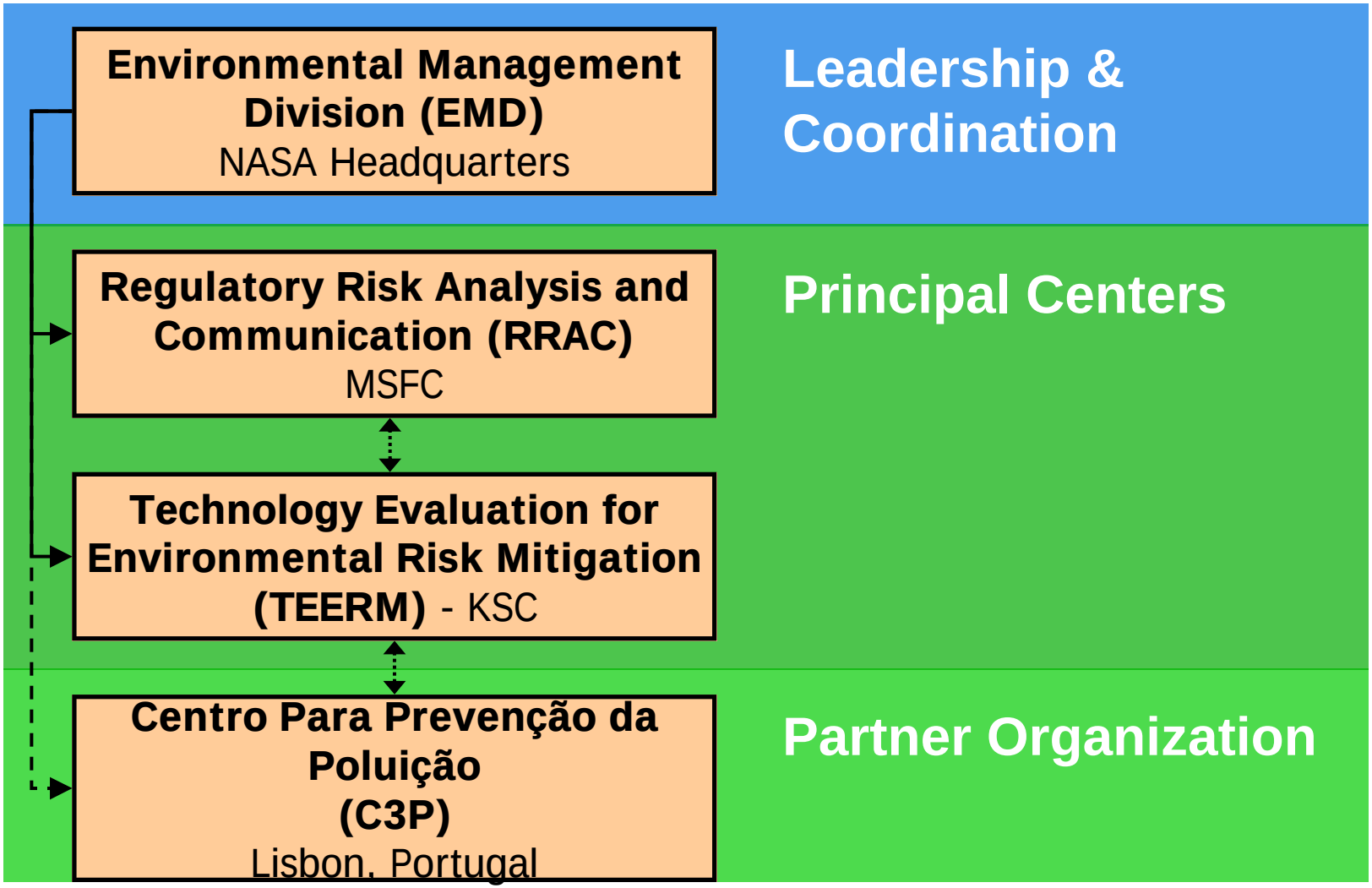
Environmental Assurance Goals

1. **Identify, analyze, and measure environmentally driven programmatic and institutional risks.**
2. **Communicate environmentally driven programmatic and institutional risks to appropriate owners (when possible, in early phases of program and project planning and execution)**
3. **Team/partner with risk owners to proactively reduce risk's impact, likelihood, and scope (e.g., may apply to multiple programs and projects)**
   - Influence regulatory authorities
   - Acquire special waivers, if possible, from regulating organization
   - Identify and validate appropriate solutions for mitigation of environmentally driven risks. As needed, adapt high-TRL technology and/or increase TRL for new technology for NASA's use.

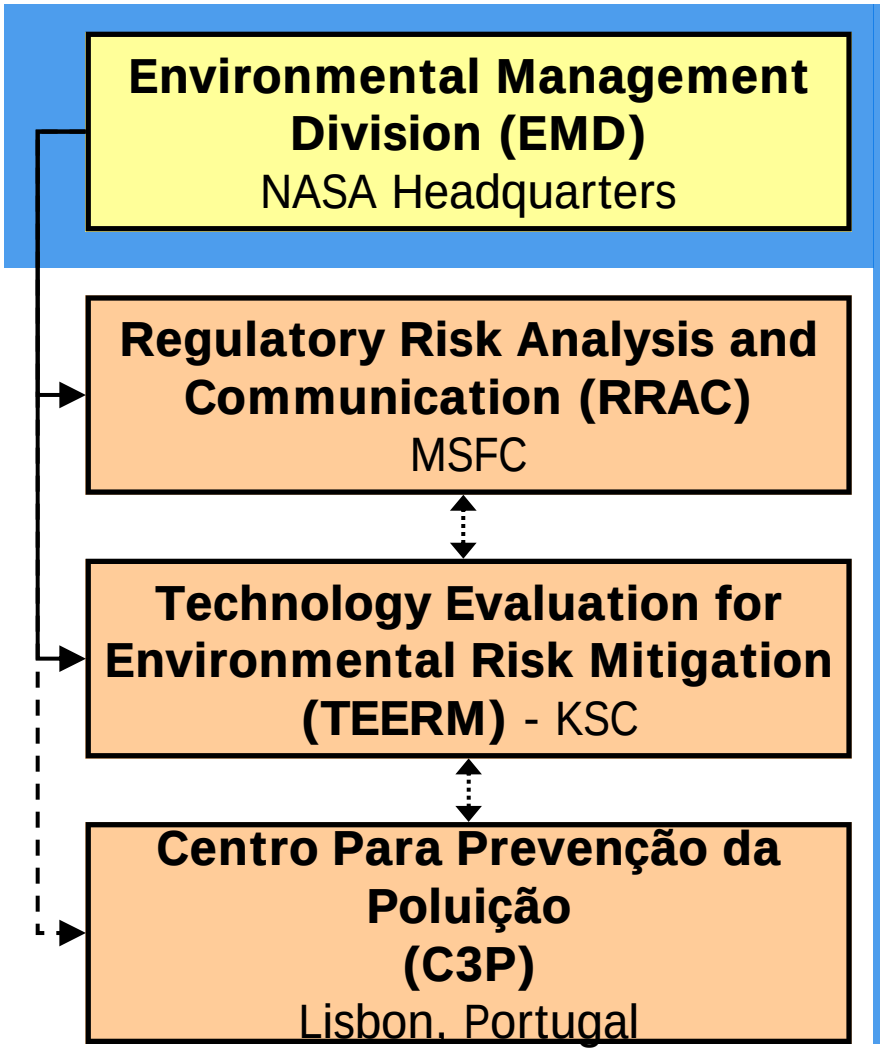
The risk owners (e.g., programs and projects) will have day-to-day responsibility for management of their risks.

Environmental Assurance Structure

Environmental Assurance Structure

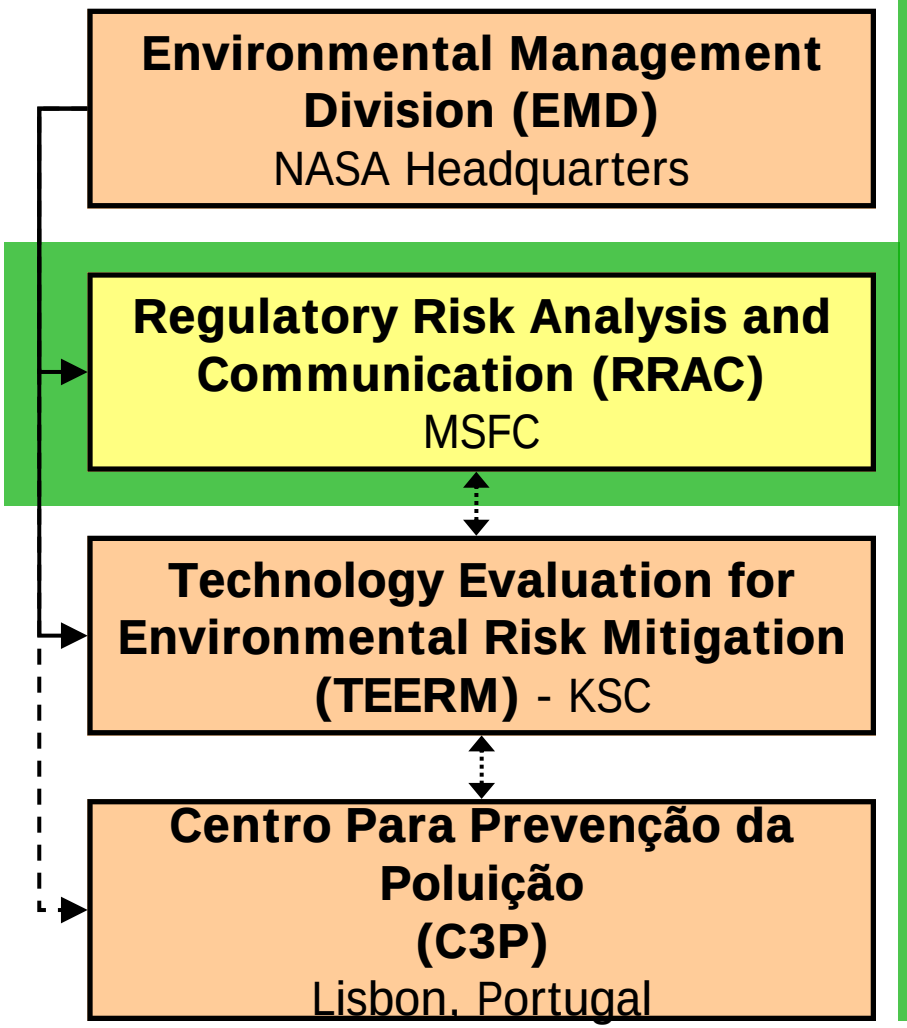


Leadership & Coordination - EMD



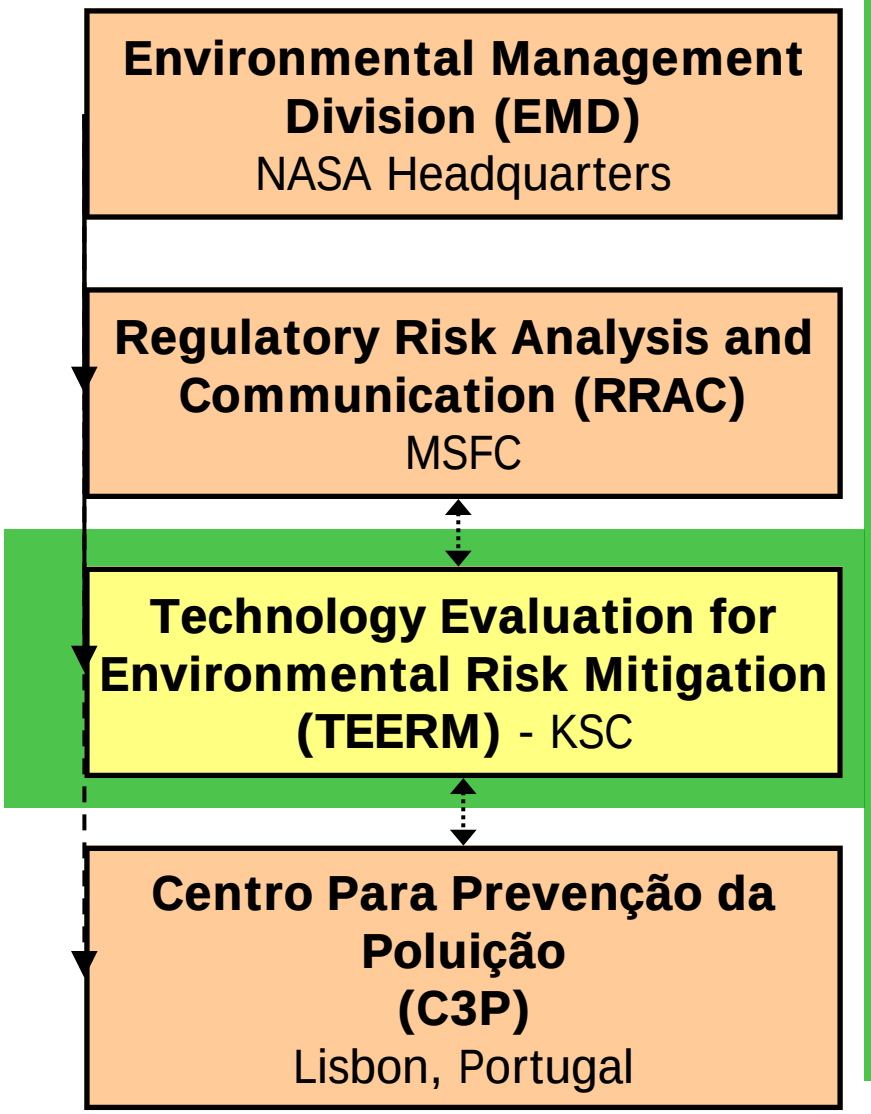
- **Provides management oversight of Principal Centers**
- **Interfaces with partner organizations - SEA, JGPP, JANNAF, CAASSC**
- **Coordinates activity with regulatory agencies**
- **Provides legislative support, policy review, and guidance**

Principal Center – RRAC



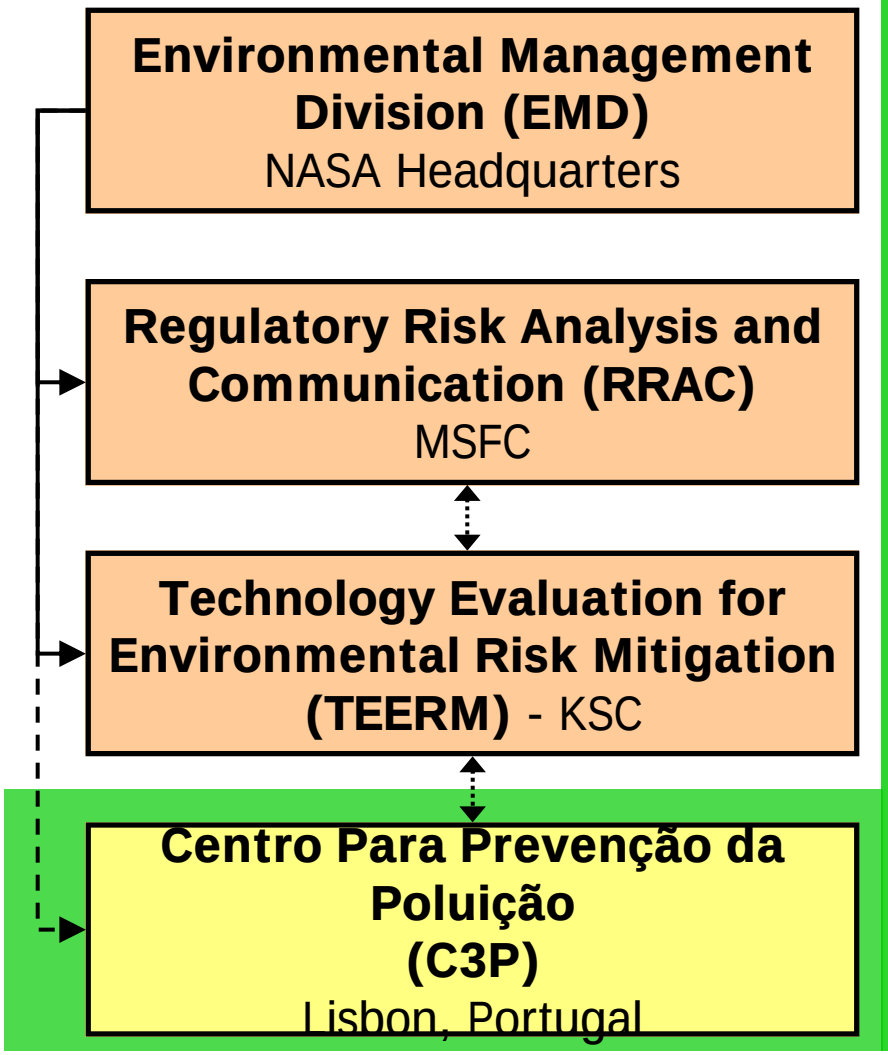
- Performs regulatory review and impact analysis
- Captures and analyzes emerging risks
- Develops mitigation options
- Recommends actions for influencing regulatory authorities
- Communicates risks to NASA programs and projects

Principal Center – TEERM



- Leads work to identify and test environmentally preferable alternative materials and processes
- Analyzes materials and processes
  - Manages joint test projects
  - Disseminates test results
  - Develops risk mitigation options
- Participates with partners on joint projects – C3P and Joint Group on Pollution Prevention (JGPP)

Partner Organization – C3P



- Works with multiple European partners
- Conducts joint projects focusing on elimination of hazardous materials to meet emerging EU regs.
- Operates in ways similar to TEERM
- Monitors European projects concerning elimination of hazardous material
- Provides conduit into European Union for other activities of interest to NASA (e.g., energy, REACH, lead-free solder)

Partnerships

Shuttle Environmental Assurance (SEA)	• EMD serves on Steering Committee • RRAC and TEERM participate
Joint Group on Pollution Prevention (JGPP)	• EMD is a member • TEERM is implementation lead
Joint Army, Navy, NASA and Air Force (JANNAF)	• Participate within Safety and Environmental Protection Subcommittee (SEPS)
Department of Defense Clean Air Act Services Steering Committee (DOD CAASSC)	• EMD is a member • Provides insight into impacts from regulation

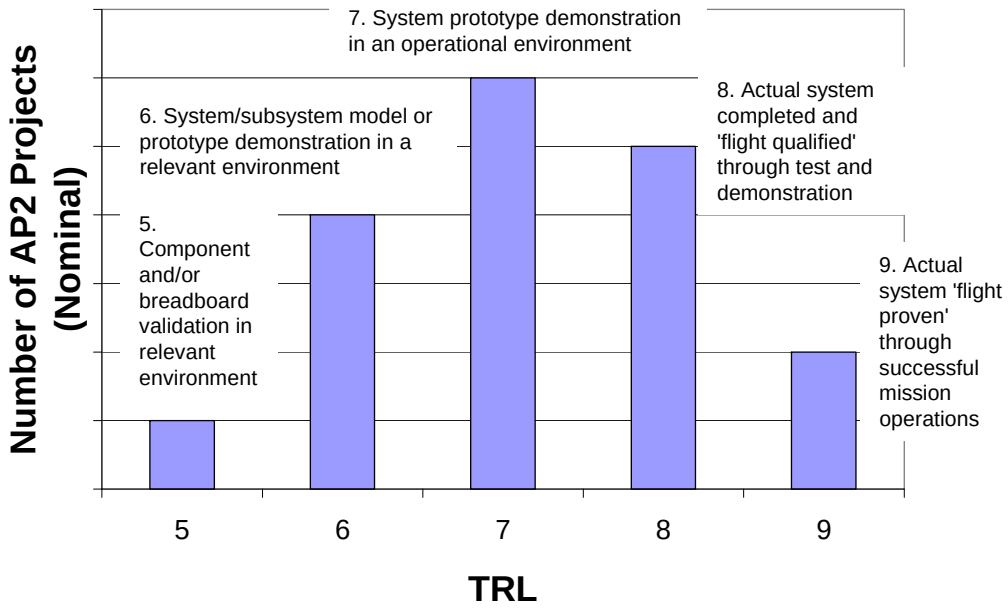
RRAC - Regulatory Risk Analysis and Communication TEERM - Technology Evaluation for Environmental Risk Mitigation

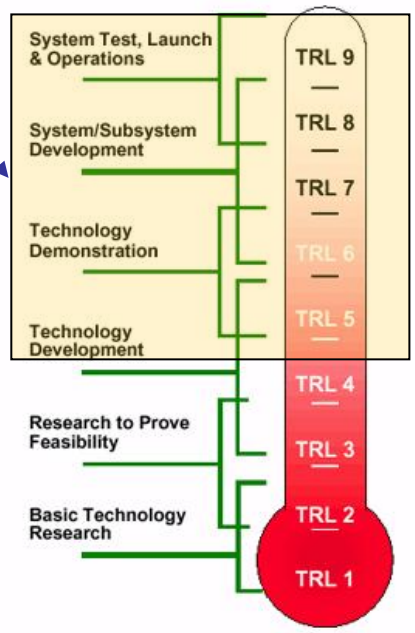
TEERM Program Background

- Role of TEERM in joint projects
  - Project manager where NASA has prime interest
    - Other projects TEERM is team member/ NASA liaison, ensuring that NASA requirements are addressed
  - Source of funding for testing (seed money)
  - Author of joint technical documents
  - Follow through to next logical step (implementation, further testing, or back to R&D).

TEERM Program Background

- TEERM approach to project development and execution:
  - Stakeholders from two or more NASA Centers/ Programs, or two or more Agencies (e.g., NASA and Air Force)
  - Objective to demonstrate/validate new materials or processes to replace hazardous materials to mitigate risks
    - Work efforts with Technology Readiness Levels 5 thru 9

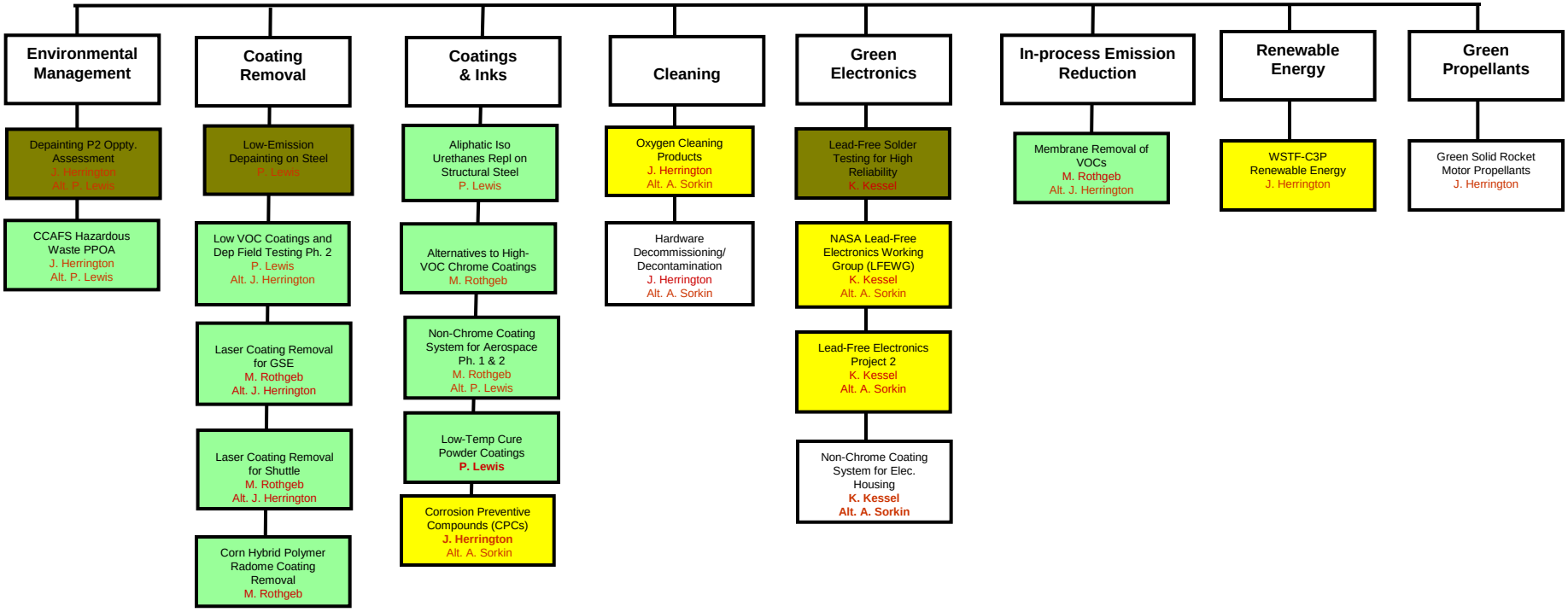




National Aeronautics and Space Administration (NASA)

TEERM Project Work Breakdown Structure

Active and Developing Projects



= completed project

= active project

= a developing project idea

= future consideration

www.teerm.nasa.gov

In-process Emission Projects

National Aeronautics and Space Administration (NASA)

Membrane Removal of VOCs

Matt Rothgeb (P) and John Herrington (S)

Description:

- Demonstrate the feasibility of a membrane unit for removing VOCs from one or more contaminated process air streams (e.g., remediation, paint booth, solvent cleaning, metal finishing, solvent recycling)
- Technology is near to COTS stage, very new and promising for several types of air contaminants
- Applied Membrane Technologies, Chembrane and New Jersey Institute of Technology have agreed to construct mobile test platform in order to test on a wide spectrum of processes and locations.

Stakeholders:

- NASA Centers (KSC, WFF, MSFC, GRC, Plumbrook, MAF, WSTF, JPL), NASA Clean Air Working Group, and C3P.

Membrane module

Benefits:

- Reduce VOC emissions by capturing emissions and condensing them into liquid form. Liquid can then be reused if pure solvent or recycled (fuels blending)
- Reduce VOC's of process air streams and remediation sites by >95%.

Achievements:

- Secured funding from NASA and in-kind contributions from team (NJIT, AMT and Chembrane).
- Began development of project scope and draft test plan, including:
  - Air streams and contaminants
  - Performance requirements
  - Began technical / business teleconferences
  - Confirmed one test site, confirmed interest at five other sites.

Future Plans:

- Initiate mobile membrane unit construction
- Test at 3 sites in 2007
- Develop plans needed for international dem/val in 2008
  - last half CY2007
- Determine funding need and source for '08 int'l demo (estimated $25K)

TEERM Back-up Slides

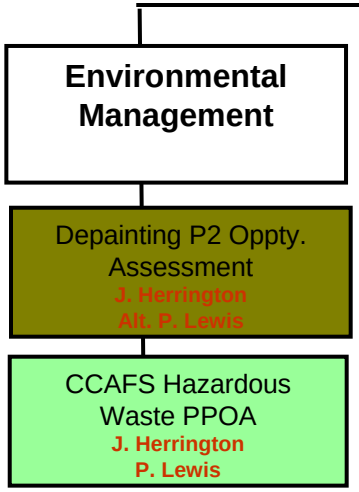
TEERM Program Background

- TEERM uses structured approach
  - Seek consensus from technical representatives on all key decisions
    - Scope of project
    - Alternatives to test
    - Testing sites
    - Conclusions of testing
  - Seek contributions from stakeholders, whether direct or in-kind.
    - Often start “seed” money with in-kind contributions. Additional/ 3rd party funding may be sought for testing.
  - Early involvement of appropriate engineering authority
    - SSP & Centers; increasingly involving Constellation
  - Support technology implementation process
  - Support evolution of technology
  - Avoid projects with export control issues

TEERM Program Background

- Benefits of TEERM approach
  - Sharing of resources reduces the cost to test and qualify alternatives
    - Historical average 6:1 return on NASA investment.

      (As high as 12: 1 ROI for participation in some efforts, like JG-PP)
  - Enhanced technical confidence in alternatives identified and tested because of direct involvement and structured methodology
  - Avoids duplication of effort among different parties
  - Improve the overall technical quality of the effort through knowledge sharing
  - Accelerates implementation of qualified alternatives.



Environmental Management Projects

National Aeronautics and Space Administration (NASA)

P2 Depainting Opportunity Assessment

John Herrington (P) and Pattie Lewis (S)

Description

- Environmentally preferable depainting methods are needed to support space/launch/range operations while reducing hazardous materials usage and total ownership costs.
- Review existing depainting processes utilized on the launch structures at Complex 17 A&B CCAFS and identify new or existing technologies or processes that may satisfy AF and NASA maintenance requirements

Stakeholders:

- NASA AP2, AFSCP2, CCAFS and Patrick AFB P2.

Benefits:

- Example of how previous studies feed into one project which later feeds another project. **Reduces total life cycle costs, eliminate duplication, and ensure best solution to support US Space civilian and military.**
- Incorporates findings of NASA Low-Emission depainting project at SSC and provides reciprocal benefit to NASA in analysis of new technologies
- Results benefit next joint project on coating and depainting at CCAFS.
- Professional network with Space Coast Launch Services

Achievements:

- The assessment is near completion. A Draft Final Report has been generated.
- Recommended evaluation of Steel Magic (R) and Sponge Jet (R) depainting technologies for large areas.
- Recommended hand tool and sanding products for small areas.
- Incorporating results from laser depainting demo at KSC.

Future Plans:

- Leverage findings into new AFSPC project: Low-VOC Coatings and Depainting Field Testing Phase 2 at CCAFS.
- Potential follow-on depainting project on LC17 Mobile Support Tower (MST)

National Aeronautics and Space Administration (NASA)

CCAFS Payload Processing/Hazardous Waste PPOA

John Herrington (P) and Pattie Lewis (S)

Description

- Conduct a P2 Opportunity Assessment of current Rocket Motor and Payload Processing and/or hazardous waste streams to evaluate and recommend potentially environmentally preferable solutions
- Assessable processes and scope still to be defined by the customer.

Stakeholders:

- Air Force Space Command
- CCAFS
- NASA.

Benefits:

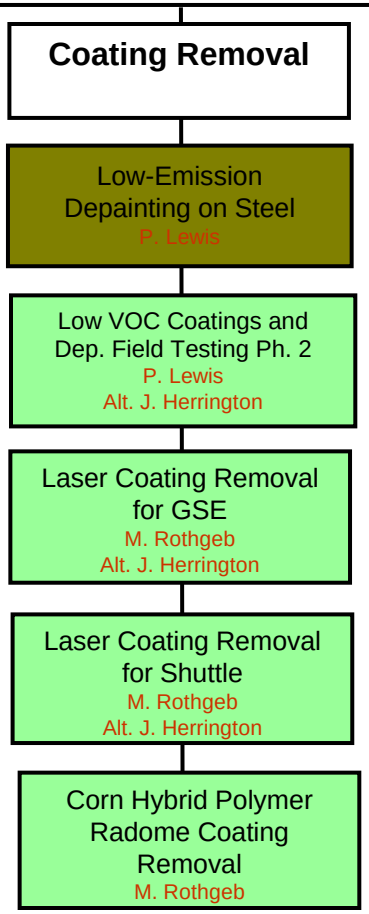
- Potential alternatives for hazardous chemicals may enhance mission success by decreasing processing time and operating costs
- Assessment likely to turn up AF issues shared by NASA as well. Evaluated technologies will benefit NASA
- May lead to future dem/val project
- Establishes new contacts within AF.

Achievements:

- Project kickoff meeting, October 2006
- 12 October meeting with AFSPC to define activity
- Initial scoping meetings held with CCAFS personnel on 6 October and 1 December 2006
- Three potential GPS launches may be added to the schedule, and opportunity to access motor and payload processing, exact schedule TBD.

Future Plans:

- Acquire waste stream data and begin analysis
- Investigate GPS mission schedule and schedule assessment visits accordingly.
- Meet with operators on 19 Dec. 2006



Coating Removal Projects

National Aeronautics and Space Administration (NASA)

Low Emission Depainting on Steel

Pattie Lewis

Description:

- Goal is to validate alternative Low Emission surface preparation/depainting technologies for structural steel
- Current methods involve high-dusting abrasive blasting
- Applicable regs.: OSHA, NIOSH, ACGIH.

Stakeholders:

- NASA Kennedy Space Center, Stennis Space Center (SSC) and Air Force Space Command.

Preparation of test panel using SpongeJet at SSC, April 2005

Benefits:

- Improved corrosion protection of critical systems
- Reduced risk associated with reduced hazardous waste
- Reduced costs associated with current maintenance activities across NASA
- In-kind contributions from vendors and team members.

Achievements:

- Completed field testing and laboratory evaluation of panels depainted at SSC and GRC.
- Testing results: Sponge Media, Hard Abrasive Media, and Plastic Blast Media technologies performed best.
- Discussed implementation & follow-on projects with team. SSC willing to allow facility to be used for future demos.
- Incorporated portable laser technology findings from GRC.

Future Plans:

- SSC plans on using one of the technologies demonstrated on an up-coming project
- Migrate findings AFSPC-NASA projects: Depainting Pollution Prevention Opportunity Assessment and Low-VOC Coatings & Depainting Field Testing Phase 2
- Explore implementation of technologies at other Centers.

Low Emission Depainting on Steel - Funding

DoD-NASA Low-Emission Depainting

Reporting Date: November 17, 2006

Status: Complete

Project Initiation Date 08/04

$ 271K
--------- = 3: 1 return on NASA direct funds
$ 90K

DIRECT FUNDING

Source	Prior Years FY03-FY05	FY 2005 5/1/05- 3/31/06	FY 2006 4/1/06- 3/31/07	FY 2007 POP	Total Direct Funding
NASA AP2	$ 89,632	$ -	$ -	$ -	$ 89,632
NASA Other (SSC)	$ -	$ -	$ -	$ -	$ -
Air Force	$ -	$ -	$ -	$ -	$ -
Army	$ -	$ -	$ -	$ -	$ -
Marines	$ -	$ -	$ -	$ -	$ -
Navy	$ -	$ -	$ -	$ -	$ -
Other Gov't (e.g., ESTCP)	$ -	$ -	$ -	$ -	$ -
Non-Gov't (e.g., OEMs)	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -
TOTALS	$ 89,632	$ -	$ -	$ -	$ 89,632

IN-KIND CONTRIBUTIONS

Source	Prior Years FY03-FY05	FY 2005 5/1/05- 3/31/06	FY 2006 4/1/06- 3/31/07	FY 2007	Total In-Kind	Total Budget
NASA AP2	$ 80,111	$ 33,880	$ 15,700	$ -	$ 95,811	$ 185,443
NASA Other (SSC)	$ 28,000	$ 14,000	$ 8,000	$ -	$ 36,000	$ 36,000
Air Force	$ -	$ -	$ -	$ -	$ -	$ -
Army	$ -	$ -	$ -	$ -	$ -	$ -
Marines	$ -	$ -	$ -	$ -	$ -	$ -
Navy	$ -	$ -	$ -	$ -	$ -	$ -
Other Gov't (e.g., ESTCP)	$ -	$ -	$ -	$ -	$ -	$ -
Non-Gov't (e.g., OEMs)	$ 50,000	$ 50,000	$ -	$ -	$ 50,000	$ 50,000
	$ -	$ -	$ -	$ -	$ -	$ -
TOTALS	$ 158,111	$ 97,880	$ 23,700	$ -	$ 181,811	$ 271,443

EXPENDITURES	Prior Years	FY 2005	FY 2006	FY 2007	Total Rec'd	Spent+ Committed	Balance
NASA	$ 80,111	$ 33,880	$ 15,700	$ -	$ 95,811	$ 95,811	$ -
Other Gov't Agencies	$ 28,000	$ 14,000	$ 8,000	$ -	$ 36,000	$ 36,000	$ -
ITB	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Other Contractor (ASRC)	$ 89,632	$ -	$ -	$ -	$ 89,632	$ 89,632	$ -
Non-Gov't (e.g., OEMs)	$ 50,000	$ 50,000	$ -	$ -	$ 50,000	$ 50,000	$ -
Other	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTALS	$ 247,743	$ 97,880	$ 23,700	$ -	$ 271,443	$ 271,443	$ -

National Aeronautics and Space Administration (NASA)

Low VOC Coatings and Depainting Field Testing (NASA-CCAFS) Phase 2

Pattie Lewis (P) and John Herrington (S)

Description:

- Test and qualify low-VOC, non-hazardous materials and processes for large-area painting and depainting maintenance operations at Cape Canaveral Air Force Station (CCAFS) LC17 Fixed Umbilical Tower (FUT) and Kennedy Space Center. Increased performance (quicker depainting time) is importance evaluation factor.

Stakeholders:

- Kennedy Space Center, AF 45th Space Wing and HQ Air Force Space Command.

Benefits:

- Eliminates risk associated with environmental, safety, and health concerns with use of paints and coatings of high VOC content and particulate emissions from depainting operations
- Reduced material obsolescence risk and ideally reduced labor costs
- Project is a continuation of previous studies conducted by NASA AP2 and AFSPC (AIU Coatings, SSC Depainting, Laser demo, Vandenberg demos) thus reducing duplication of effort and costs
- Materials tested against NASA-Standard-5008 are qualified for use across NASA.

Achievements:

- Including results of previous work
- Identified project stakeholders
- Contract awarded 9/06
- Project Kick-off

Future Plans:

- Develop Field Test Plan
- Incorporate previous studies to determine which technologies will be tested
- Field application testing of selected coatings and depainting technologies at CCAFS.

National Aeronautics and Space Administration (NASA)

NASA Portable Laser Coating Removal System for GSE

Matt Rothgeb (P) and John Herrington (S)

Description:

- Determine NASA's need for alternative method of stripping coatings on Ground Support Equipment (GSE) and Structural Steel.

Stakeholders:

- KSC, GRC and SSC
- Interest from ICBM, U.S. Coast Guard, CCAFS, AFSPC.

Benefits:

- Follow-on from JG-PP PLCRS project and NASA GRC demo, to look at KSC-specific application areas
- Decreased hazardous waste generation & associated costs
- Potential to reduce critical GSE down-time → increases mission readiness.
- Strip select areas for NDE (weld lines).

A mission-critical GSE used to transport shuttle landing gear at KSC for the Laser project

Achievements:

- Testing and demonstrations at GRC & WPAFB (Oct. – Nov. 2005).
- Testing and demonstration at KSC (Oct – Nov 2006). Dozens of NASA Gov't & Contractor attendees.
- Test articles from numerous offices
- Developing a test report and implementation plan for use of similar systems across NASA Centers for small-scale stripping applications (various systems available and suit different environments better).

- Some **Conclusions**:
  - Laser units work most efficiently on thin coatings
  - Laser units work best on non-glare, non-white surfaces due to low-reflection
  - Not practical for large-scale use as the strip rate is very low compared to conventional methods
  - Weld inspection and small areas appears to be best suited for these systems.

Future Plans:

- Follow up with all interested parties. Explore implementation possibilities within NASA and elsewhere.

National Aeronautics and Space Administration (NASA)

Laser Coating Removal for Shuttle

Matt Rothgeb (P) and John Herrington (S)

Description:

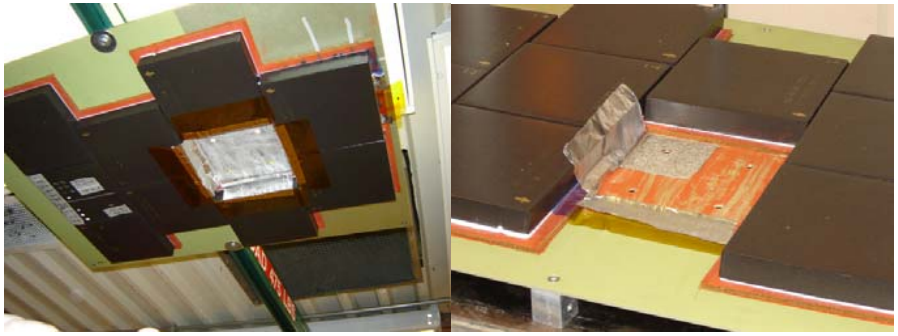
- Determined viability of lasers to replace hand sanding and plastic media blasting for removing various coatings on shuttle.

Stakeholders:

- Boeing, USA, KSC and JSC.

Benefits:

- Follow-on from JG-PP PLCRS project, to look at new application areas for use within NASA
- Decreased hazardous waste generation
- Reduced labor costs / materials cost
- Potential to reduce risk of damage and contamination around shuttle tile cavities during depainting process.



Space shuttle tile-array mock-up

Achievements:

- Nov 2005 - WPAFB stripped various coatings, Orbiter tile cavity mock-up, elevon cove seal, and window retainer.
- Oct – Nov 2006 – Demonstration at KSC to bolster buy-in from KSC contractors.
- 2005 - 2006 Test Report being developed. Some results:
  - Anodize was removed by laser stripping except when using a stationary scanning-head end effector
  - Works well to remove coatings if process allows for anodize to be removed and replaced
  - Would be best suited for small controlled room within hangar, not within open portions of the high-bay or shuttle hangers
  - Re-melt layer of substrate (very thin) is being tested for metallurgical changes and/or changes in corrosion properties prior to implementation.

Future Plans:

- Identify any other NASA/AF stakeholders for follow-on projects
- Develop NASA Specification for PLCRS use
- Final Report is due in December 2006 or early January 2007.

NASA Portable Laser Coating Removal System - Funding

NASA Portable Laser Coating Removal System

Reporting Date: November 17, 2006

Status: Active

Project Initiation Date 08/04

$ 4477K
---------- = 60: 1 return on NASA direct funds
$ 75K

DIRECT FUNDING

Source	Prior Years	FY 2006 4/01/06-3/31/07	FY 2007 POP	Total Direct Funding
NASA AP2	$ 50,000	$ 25,000	$ -	$ 75,000
NASA Other	$ -	$ -	$ -	$ -
Air Force (prior JG-PP)	$ 2,029,000	$ -	$ -	$ 2,029,000
Army	$ -	$ -	$ -	$ -
Marines	$ -	$ -	$ -	$ -
Navy (prior JG-PP	$ 15,000	$ -	$ -	$ 15,000
Other Gov't (ESTCP for JGPP)	$ 2,288,000	$ -	$ -	$ 2,288,000
Non-Gov't (vendors)	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -
TOTALS	$ 4,382,000	$ 25,000	$ -	$ 4,407,000

IN-KIND CONTRIBUTIONS

Source	Prior Years	FY 2006	FY 2007	Total In-Kind	Total Budget
NASA AP2	$ -	$ 20,000	$ -	$ 20,000	$ 95,000
NASA Other	$ -	$ -	$ -	$ -	$ -
Air Force	$ -	$ -	$ -	$ -	$ 2,029,000
Army	$ -	$ -	$ -	$ -	$ -
Marines	$ -	$ -	$ -	$ -	$ -
Navy	$ -	$ -	$ -	$ -	$ 15,000
Other Gov't (e.g., ESTCP)	$ -	$ -	$ -	$ -	$ 2,288,000
Non-Gov't (vendors)	$ 50,000	$ -	$ -	$ 50,000	$ 50,000
	$ -	$ -	$ -	$ -	$ -
TOTALS	$ 50,000	$ 20,000	$ -	$ 70,000	$ 4,477,000

EXPENDITURES	Prior Years	FY 2006	FY 2007	Total Rec'd	Spent+ Committed	Balance
NASA	$ -	$ -	$ -	$ -	$ -	$ -
Other Gov't (AFRL)	$ 690,248	$ 25,000	$ -	$ 395,099	$ 395,099	$ -
ITB	$ -	$ 20,000	$ -	$ 20,000	$ 20,000	$ -
Other Contractor	$ 3,691,752	$ -	$ -	$ 79,901	$ 79,901	$ -
Non-Gov't (vendors)	$ 50,000	$ -	$ -	$ 50,000	$ 50,000	$ -
Other	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
TOTALS	$ 4,432,000	$ 45,000	$ -	$ 545,000	$ 545,000	$ -

National Aeronautics and Space Administration (NASA)

Corn Hybrid Polymer Radome Coating Removal

Matt Rothgeb

Description:

- To demonstrate and validate corn hybrid polymer media for safely removing coatings from composite surface.

Stakeholders:

- JG-PP (Navy (lead), Air Force and NASA)

Benefits:

- Reduce damage to delicate substrates during coating removal process so as not to impair mission readiness.
- Reduce hazardous waste and associated costs
- Media is biodegradable and recyclable.

Funding:

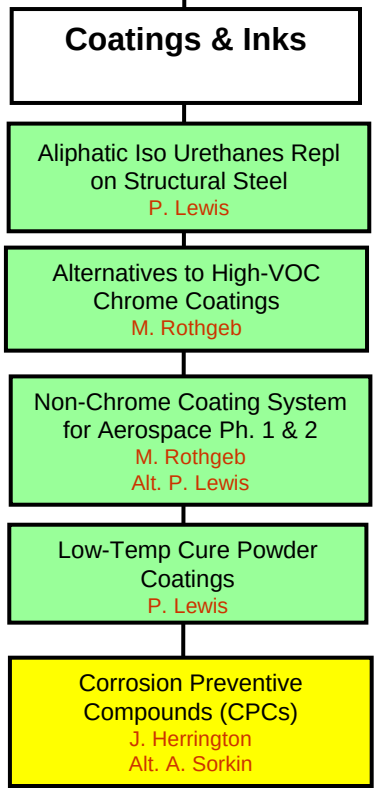
- On September 30, 2005, the NDCEE received notification of award of the Joint Services Initiative (JSI) task, which includes the 429-N1 project, Evaluation of Corn Based Blasting Media.
- The project was officially kicked off on October 2005.

Achievements:

- Preliminary evaluation conducted on U.S. Navy surface ship on radome sections and passive countermeasure system (PCS)
- Field demonstration of the technology in December 2005 at Warner Robins AFB, GA. More field demonstrations are being planned for 2006
- NASA stakeholders were contacted and materials / coatings were discussed. There is currently no interest in submitting a NASA test panel, but interest in results from JG-PP testing. CHP may be alternative for Plastic Media Blasting at KSC or other sites.

Future Plans:

- Continue promoting CHP technology within NASA.
- Assist JG-PP as required to develop business strategy (determine testing costs, cost shares, contractual aspects and testing locations)
- Assist in development of technical and business products (e.g., JTP, SOW) necessary to proceed testing as requested by JG-PP and NDCEE.



Coating & Inks Projects

National Aeronautics and Space Administration (NASA)

Alternatives to Aliphatic Isocyanate Urethanes

Pattie Lewis

Description:

- Goal is to validate alternatives to isocyanate urethanes
- Currently isocyanate urethanes are used across NASA on structural and non-structural elements in both shuttle and non-shuttle programs
- Applicable regs.: OSHA, NIOSH, ACGIH.

Stakeholders:

- NASA Kennedy Space Center, Stennis Space Center and Air Force Space Command.

Preparation of test panel at KSC Coatings Application Laboratory

Benefits:

- Reduced risk associated with environmental, safety, and health concerns that come with the use of isocyanate urethanes, VOCs, and HAPs
- Reduced material obsolescence risk due to environmental regulations
- Findings applicable to both NASA and AFSPC .

Achievements:

- Phase I Screening tests completed
- Viable candidates for follow-on testing identified (3 zinc-siloxane and a water-based urethane) and Phase 2 testing began
- Panels with all alternatives placed on beach for 18-month Marine exposure test
- Performed 6-month and 12-month field evaluations at SSC with some alternatives showing good results.

Future Plans:

- Migrate findings on viable technologies to AFSPC-NASA project, Low-VOC Coatings & Depainting Field Testing Phase 2
- Disseminate findings within KSC and SSC & help evaluate and incorporate results into any revised facility maintenance standards.

National Aeronautics and Space Administration (NASA)

Alternatives to High-VOC Chrome Coatings for Aircraft Exteriors (C3P)

Matt Rothgeb

Description:

- Demonstrate low-VOC and non-chrome coating systems on Portuguese commercial aircraft
- The identification/qualification of hex-chrome free coating systems is a Portuguese priority due to national & European safety and environmental regulations.

Stakeholders:

- TAP Air Portugal, OGMA (Indústria Aeronáutica de Portugal), C3P and NASA AP2.

Benefits:

- Reduced materials obsolescence risk if non-chrome paint system can be qualified for aerospace
- Decreased costs associated with environmental and occupational health/safety regulations.

Accomplishments:

- Painted exterior service door of a TAP Airbus A319 and dip-applied non-chrome pretreatment on several panels (Oct 2004)
- Visual inspections appeared favorable with no visual signs of deterioration in thickness or color. Future inspections will take place in 2007.
- NASA laboratory testing completed in September 2006.
- C3P (ISQ) testing begun.
- Findings from door being flight tested transferable to new (Ph. 2) AP2 Non-Chrome Coating Systems for Aerospace project (subject to preliminary screening tests).

Future Plans:

- Continue monitoring of coating performance on service door
- Build final test report – incorporate US and International data. (ISQ report expected 1st Qtr 2007)
- Work toward implementation in US sectors of interest.

National Aeronautics and Space Administration (NASA)

Non-Chrome Coating System for Aerospace Phase 1 and 2

Matt Rothgeb (P) and Pattie Lewis (S)

Description:

- Evaluation and testing of non-chromated coating systems as replacements for hexavalent chrome coatings in aircraft and aerospace applications.

Stakeholders:

- NASA (KSC, MSFC, Boeing, RSRM, ATK Thiokol, Hill AFB, United Space Alliance, SSME, SEA)
- Air Force (Hill AFB, WPAFB AFRL & MLBT).

Benefits:

- Meet EPA and OSHA requirements
- Reduce maintenance cost and government liability associated with continued use of chrome-containing coatings
- Addresses NASA and Air Force requirements on AL alloys 2219, 2195, 6061, 2024 Bare, 2024 Clad, and 7075.

Achievements:

- Outlined Phase 1 testing requirements
- Procured all materials and coated panels
- Sent finished panels to respective test sites and began testing.

Future Plans:

- Finish the Phase 1 laboratory testing
- Select coatings for Phase 2 testing
  - Probably four coatings, one of which is a previously-untested magnesium coating
- Help AF with Non-chrome Coating System standard.

National Aeronautics and Space Administration (NASA)

Low Temperature Cure Powder Coatings

Pattie Lewis

Description:

- To demonstrate/validate powder coating resins for corrosion-protection of temperature-sensitive weapon system components (aluminum and magnesium substrates). Specifically, resins will be developed that are low temp. curable (below 250 deg F), durable, corrosion-inhibiting and weather resistant
- New materials developed by GE Global Research and Crosslink Powder Coatings Inc. during SERDP Project PP-1268.

Stakeholders:

- KSC, Orbiter (Boeing Huntington Beach), Air Force Material Command (Project Lead), Air Force, Navy, Department of Energy, JG-PP and ESTCP.

Benefits:

- New low-temperature cure powder coating technology will improve the manufacturability, use, and repair of temperature-sensitive, coating-protected weapons, aircraft, and auxiliary equipment
- Elimination of toxic chemicals and VOCs thus minimizing risks to human health and environment and thus reduced costs associated with regulations
- A typical powder coating resin has the potential to reduce labor and material costs by a factor of 10 or more while total wastes and VOCs can be reduced by a factor of 100 or more.

Achievements:

- NASA requirements included as a JTP Addendum
- Project is coating NASA test panels in-kind
- Boeing is donating in-kind materials and testing
- NASA AP2 Office only needs to contribute an additional **$5K** for NASA-specific requirements.

Future Plans:

- Prepare test coupons and initiate testing.
- Track NASA test specimens.

National Aeronautics and Space Administration (NASA)

Corrosion Preventive Compounds (CPC)

John Herrington (P) and Al Sorkin (S)

Description:

- Solid Rocket Motor Propellant Issue:

-Many materials that would otherwise resist corrosion fail in the KSC environment due to the acidic exhaust from solid rocket boosters. These materials can be costly to replace or maintain, and pose environmental (esp. VOC) concerns. Cryogenic flex hoses are routinely removed from the pad for maintenance. Corrosion Preventive Compounds (CPCs) are used by NASA, DOD, AFSC, and others. Testing is needed to evaluate the performance of CPCs under KSC launch pad conditions.

- Most CPC's are high VOC content which put them at risk for obsolescence. CPCs are inexpensive and easy to apply.

Stakeholders:

- NASA Launch Services Program, VA-A, Constellation Program, AFSPC, Shuttle Program.

Benefits

- CPCs provide a relatively low cost and low maintenance method for preventing corrosion on existing structures.
- Reduces mission schedule risk by increase lifetime of launch pads and GSE and reducing replacement and maintenance cost.
- Reduce Risk of Obsolescence on Shuttle Pad flex lines due to production halt of AR7
- Area of keen interest by AFSPC, JCAA and Services; leveraging likely from DoD

Applications

- Launch pads and GSE
- All structures exposed to Solid Rocket Propellants:
  - AFSPC shares mutual interest due to planned continued use of solid rocket booster propellants.

National Aeronautics and Space Administration (NASA)

Corrosion Preventive Compounds (CPC)

Approach:

CPCs from different manufacturers will be applied to different metals including steel and aluminum alloys. Preliminary screening will involve exposing the CPC coated alloys in an accelerated corrosion salt fog chamber. Materials, including flex hoses, that pass initial testing will be exposed at the KSC Corrosion Beach Site and will be periodically rinsed with a mixture of hydrochloric acid and alumina to simulate the conditions from the SRB exhaust. After exposure the alloys will be evaluated for corrosion resistance.

Efforts will progress from previous studies by JCAA and USN aviation applications and rewriting of CPC standards.

Products

- List of CPCs that protect and extend the life of existing launch pad structures and GSE from acidic solid rocket booster exhaust
- Guidance on which CPC to select for a specific application.

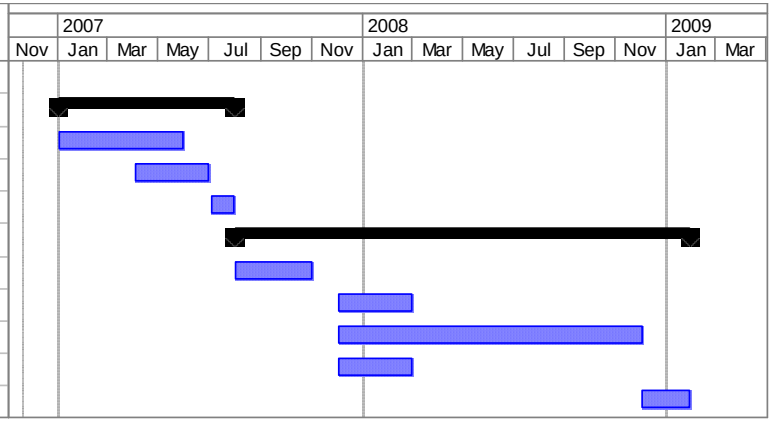
Decision Rationale:

NASA Corrosion Technology Laboratory has many years of experience evaluating and testing corrosion prevention technologies. The work can be done at CTL's atmospheric exposure beach site and accelerated corrosion facility.

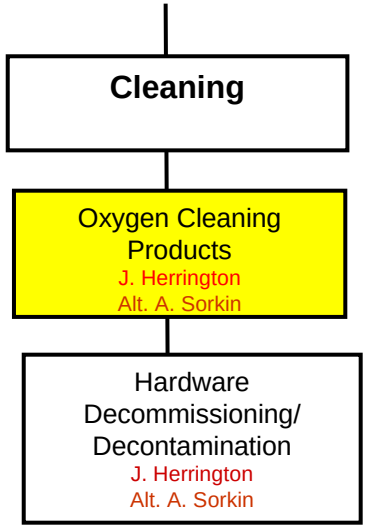
Support Required: $50k

Schedule:

ID	Task Name	Start	Finish
1	**CPCs for Flight Hardware and GSE**	Wed 11/15/06	Wed 11/15/06
2	**Ph 1. CPC Survey and Data Analysis**	**Mon 1/1/07**	**Tue 7/31/07**
3	CPC survey	Mon 1/1/07	Thu 5/31/07
4	Data analysis	Mon 4/2/07	Fri 6/29/07
5	Prep test panels	Mon 7/2/07	Tue 7/31/07
6	**Ph. 2. Laboratory Analysis of CPCs**	**Wed 8/1/07**	**Wed 1/28/09**
7	Screening tests	Wed 8/1/07	Wed 10/31/07
8	Common tests	Mon 12/3/07	Fri 2/29/08
9	Atmospheric corrosion tests	Mon 12/3/07	Mon 12/1/08
10	Electrochemical test	Mon 12/3/07	Fri 2/29/08
11	Data analysis	Mon 12/1/08	Wed 1/28/09



Cleaning Projects



National Aeronautics and Space Administration (NASA)

Oxygen System Cleaning

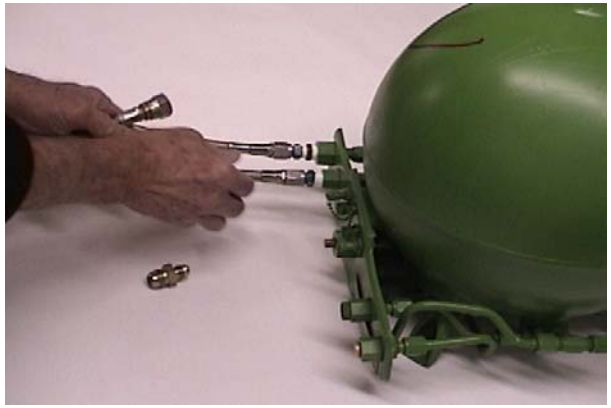
John Herrington (P) and Al Sorkin (S)

Objective:

- The primary objective of this project is to prepare a Guidance Document that will assist NASA in determining areas of risk associated with Class II ODC's in Oxygen Line/Systems Cleaning.
- Current best-available products for cleaning space oxygen systems are Class II ozone depleting substances, which must be phased out by 2015. Finding viable replacements will be imperative to avoid conflict with mission requirements.

Stakeholders:

- NASA, AFSPC, & potentially all government and commercial user cleaning oxygen systems or components.



Benefits:

- Summarize Class II ODC issues and compare/contrast previous and future cleaning product development and test programs.
- Use Guidance Document to guide policy development, to develop Agency strategy, and to inform programs of potential Class II ODC impacts.
- Greatly reduce risk associated with current Class II ODC cleaning products.

Achievements:

- Communication initiated with WSTF and product manufacturers, 3M, Asahi Glass, Micro Care, USAF/NATO, EPA, etc.

Future Plans:

- Gather and analyze information on Class II ODC regulations and on non-ODC cleaning product development and test programs.
- Inform NASA of future non-ODC cleaning product opportunities and identify areas where non-ODC cleaning product implementation could be possible.
- Identify technical gaps in non-ODC cleaning products for O2 cleaning and recommend future development/ testing, possible task academia to explore designer chemicals.
- Identify risks to NASA of different non-ODC cleaning scenarios (both switching to non-ODCs as well as staying with Class II ODCs).

National Aeronautics and Space Administration (NASA)

Hardware Decommissioning/ Decontamination

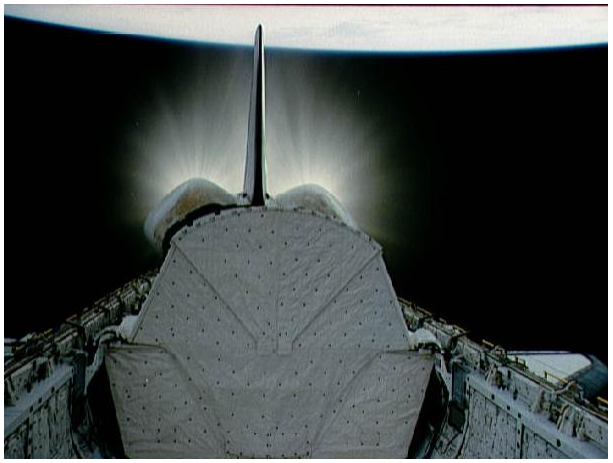
John Herrington (P) and Al Sorkin (S)

Objective:

- Develop methods to decontaminate Hypergolic fuel and other hazardous residue from space systems for museum or static display applications
- Eliminate the need for hazardous material storage for used space flight hardware
- Investigate technologies: Historical methods, plasma, UV, microwave, techniques from other industries such as medical, chemical, nuclear.

Stakeholders:

- NASA propellant system programs and centers: WSTF, JSC, MSFC, SSC, {add more?}
- Possible Air Force Space Command.



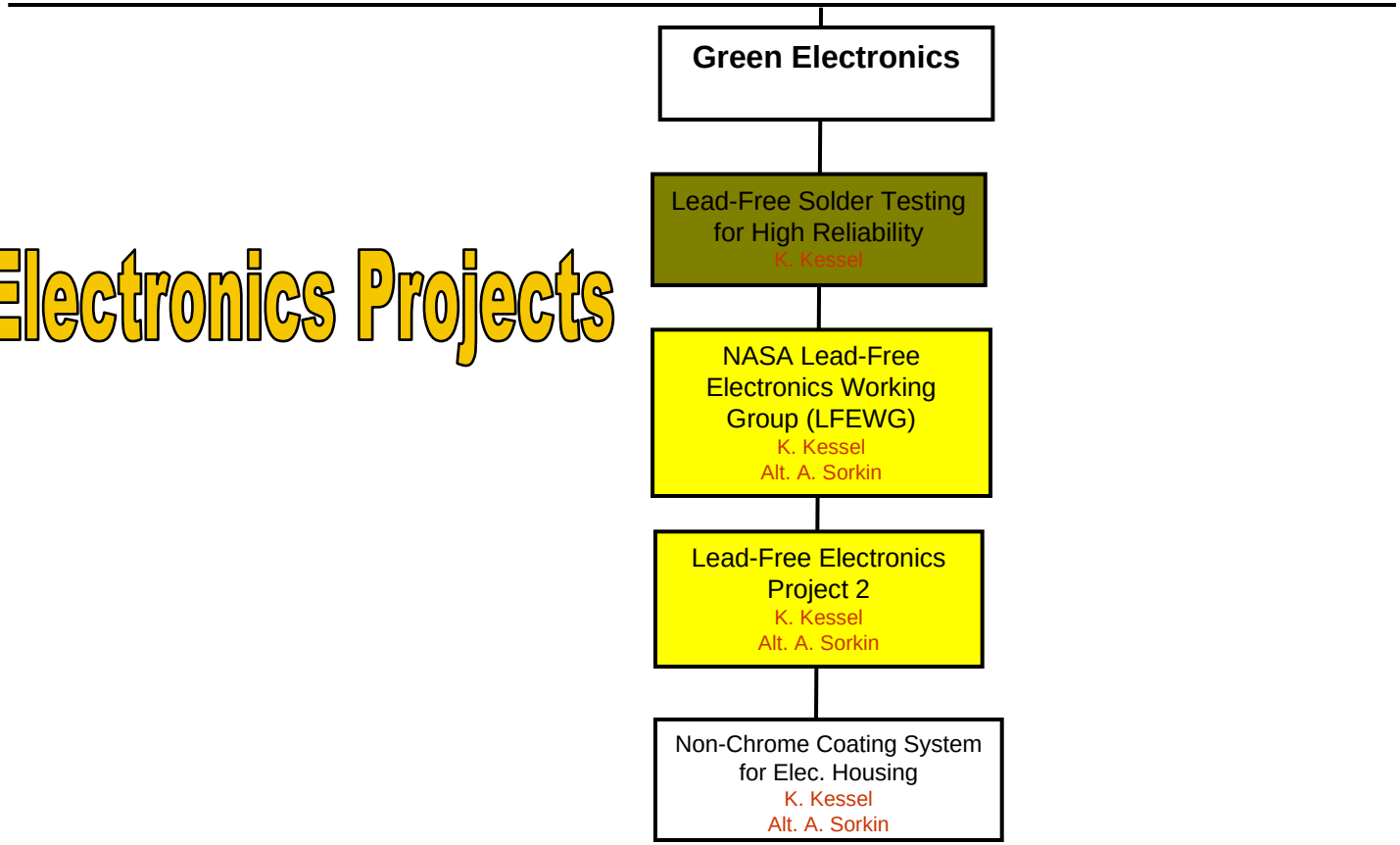
Benefits:

- Reduces risk associated with bulk hazardous waste of contaminated equipment items
- Reduces risk associated with storage and protection requirements for decommissioned contaminated equipment
- Eliminate personnel exposure risks
- Reduce risks to all centers with hypergolic fuel hardware.

Future Plans:

- Define scope of hazards & equipment
- Investigate possible alternatives and contact subject matter experts
- Evaluate potential decontamination ideas that may meet the need to decontaminate hypergolic fuel contamination
- Initiate dem/val project.

Green Electronics Projects



National Aeronautics and Space Administration (NASA)

LFS Testing for High-Reliability Applications

Kurt Kessel (P) and Brian Greene (S)

Description:

- Joint DoD-NASA-OEM project to provide baseline data to allow eventual qualification and validation of lead-free solder alloys for use in manufacture and repair of electronic equipment
- Consumer electronics are driving commercial market to lead-free alternatives.

Stakeholders:

- NASA KSC, JPL, MSFC, JSC, GSFC, ARC, USA-SRB, Boeing-Orbiter
- Air Force, Army, Navy, Marines, Dept. of Energy
- More than 25 manufacturers and vendors.

Test equipment and rework (removal and replacement) of LFS at BAE Systems, TX

Benefits:

- NASA AP2 becoming focal point for new Agency, DoD, and International lead-free solder initiatives
- JTP meets NASA core testing needs (confirmed buy-in from NASA MSFC, Boeing/Orbiter, JPL).

Achievements:

- Results highly anticipated by NASA & industry. **Issues critical for Constellation program risk reduction.**
- Findings of high value to hundreds of stakeholders. No one else looking at lead-free solder for high reliability applications as in depth
- JCAA/JGPP session at SMTAI had some of the highest grades from session surveys.
- Team members ready to participate in more testing (follow-on).
- **Conclusions and recommendations**
  - Under certain conditions, Pb-free solders may work. But need to further evaluate for specific aerospace and defense electronics in some use environments.
  - Next steps; Working to initiate a follow-on project, top candidate includes:
    - Lead-free electronics Rework including reliability of mixed, SnPb/lead-free & lead-free/SnPb, solder joints

National Aeronautics and Space Administration (NASA)

NASA Lead-Free Electronics Working Group

Kurt Kessel (P) and Al Sorkin (S)

Description:

- Coordinated action by various engineering and safety entities within NASA is needed to mitigate the risk of lead-free electronics. The need to address the issue on an urgent basis stems from the reality that the industry shift to lead-free is occurring rapidly. **Both safety and mission-critical parts/components are at risk and there are presently no fully proven avenues of mitigation other than avoidance of use.**

Stakeholders:

- MSFC, JSC, KSC, NASA HQ, Constellation, JPL, GSFC.

Benefits:

- Program goals would accommodate needs of varied program (short term, manned, deep space, etc.)
- Stand-alone funding (not out of AP2 core)
- Use to develop new LFS follow-on projects.

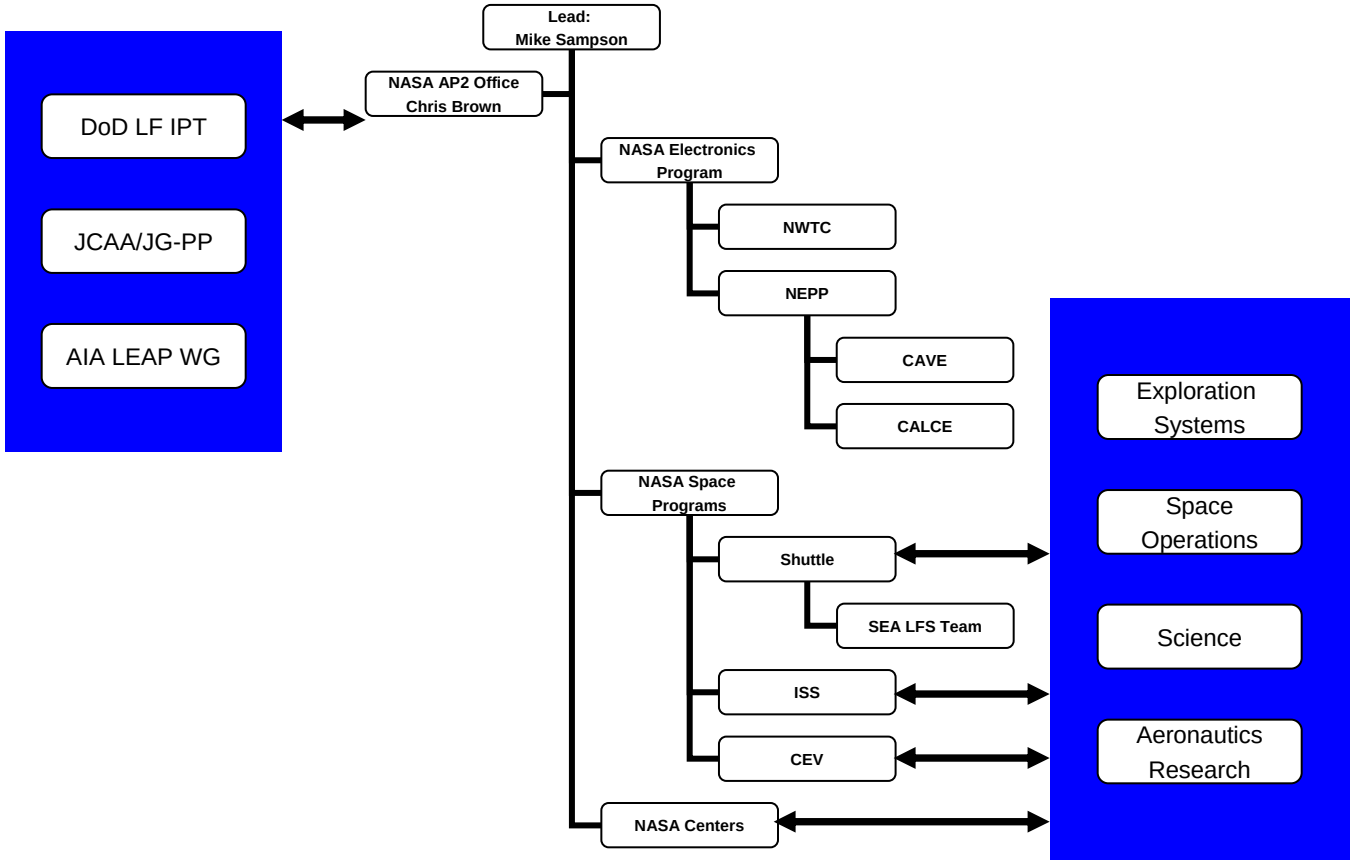
Achievements:

- Initial meeting with NEPP and AP2 Office Sept. 2006. Agreed that our offices should work together to identify and fill lead-free electronics data gaps.
- GSFC to work tin whiskers
- AP2 to work reliability issues with lead-free electronics

Future Plans:

- By 1/07, revise AP2 Task Order (sent to Sampson) to get NEPP funding. Coordinate initial NASA LFEWG teleconference – January 2007
  - **If funds not received, still valuable for AP2 to work, will require funding from non-NEPP source**
- Develop and implement a NASA Policy Directive on lead-free electronics – Draft by 1st quarter 2007
- Finalize NASA Policy Directive on lead-free electronics – 3rd quarter 2007
- LFEWG would work to establish the NASA technical requirements for the Lead-Free Electronics Project 2.

NASA Lead-Free Electronics Working Group



NEPP and the NASA AP2 program have initiated a partnership in Lead-Free Electronics (LFE) to address that major electronic equipment manufacturers are proceeding with the implementation of environmentally friendly (lead-free and halide-free) assemblies on a global basis.

National Aeronautics and Space Administration (NASA)

Lead-Free Electronics Project 2 –

Lead-free Electronics Rework

Kurt Kessel (P) and Al Sorkin (S)

Description:

- Joint DoD-NASA-OEM project will build on the results from the JCAA/JGPP LFS Project focusing on the Rework of SnPb and lead-free solder alloys and will include the mixing of SnPb/lead-free & lead-free/SnPb solder alloys
- **Consumer electronics are driving commercial market to lead-free alternatives causing a situation where aerospace OEMs and agencies must deal with the introduction of lead-free in to high reliably electronics.**

Stakeholders:

- NASA KSC, JPL, MSFC, JSC, GSFC, ARC, USA-SRB, Boeing-Orbiter
- Air Force, Army, Navy, Marines, Dept. of Energy
- More than 25 manufacturers and vendors.

Benefits:

- Project will fast-track since we are building off of the JCAA/JGPP LFS Project
- Data generated from the this project is required to gain a better understanding of how lead-free electronics will perform in high-reliability aerospace applications.
- Even though NASA and the aerospace community are exempt from lead-free laws and regulations, there may not be enough suppliers available to meet needs
- Military and aerospace OEMs are receiving unwanted electronics components with lead-free finishes

Accomplishments:

- Initial technical project meeting was held October 27, 2006
- Project proposal including technical details and testing requirements is in draft.

Future Plans:

- Finalize JTP and test vehicle design
- Identify test sites
- Explore stakeholder funding (e.g. ACI/MANTECH)
- **Seed funding ($100K) required to pay for test articles by Summer 2007.**

National Aeronautics and Space Administration (NASA)

Non-Chrome Coating System for Electronic Housings

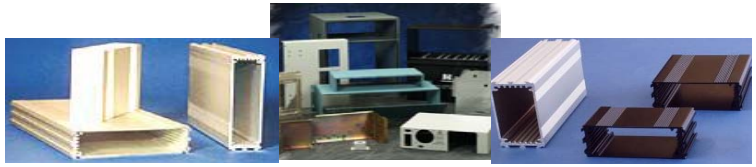
Kurt Kessel

Description:

- Evaluation and testing of non-chromated coating systems as replacements for hexavalent chrome coatings used on electronics housings
- Manufacturers of electronic housings for commercial products are known to be implementing chrome-free coating systems
- Recently lowered hexavalent chromium permission exposure limit (PEL) is forcing all electronics manufacturers to evaluate chrome-free coatings, it is not known whether the commercial chrome-free coatings will suffice in harsh military/aerospace environments.

Stakeholders:

- NASA KSC, JPL, MSFC, JSC, GSFC, ARC, USA-SRB, Boeing-Orbiter
- Air Force, Army, Navy, Marines, Dept. of Energy
- More than 25 manufacturers and vendors.



Benefits:

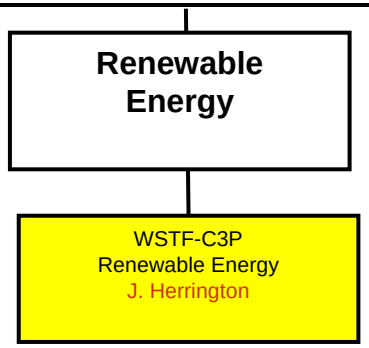
- Meet EPA and OSHA requirements
- Meet European RoHS requirements
- Reduced hazardous materials associated with electronics equipment
- Some of the chrome-free coating systems being tested in the NASA AP2 projects may also have promise as a replacement, testing of the chrome-free coatings to military/aerospace specs will address concerns about the viability of these coatings
- If implemented, chrome-free coating systems on electronic housings will greatly reduce chromium emissions and waste generation from manufacturing and repair site.

Achievements:

- Identified potential project stakeholders and their requirements
- Project requirements survey and materials identification form sent out.

Future Plans:

- Continue to communicate with potential project stakeholders
- Continue to develop interest in the project.



Renewable Energy Projects

National Aeronautics and Space Administration (NASA)

WSTF-C3P Renewable Energy Project

John Herrington

Description:

- Initiate a 5 year phased program in renewable energy beginning with studies and planning to install a wind power generation farm at WSTF for remediation power
- Future efforts will include incorporation of Solar Power, and leading to the production of hydrogen for fuel cell use
- Eventual goal to make WSTF a premier Hydrogen test bed for development and infrastructure, with benefits to NREL, C3P as well as NASA.

Stakeholders:

- NASA WSTF and possibly other sites; National Renewable Energy Laboratory (DOE); C3P Partners El Paso Electric Co.
- Potential DOD Partners
  - WSMR
  - Ft. Bliss
  - Holloman AFB

Benefits:

- Provide immediate energy assistance to WSTF for Ground water remediation needs, 1 Megawatt continuous power
- Aid in advancements in renewable energy:
  - Merging Wind and Solar power for hydrogen production
  - Develop efficient methods of production, storage and delivery of Hydrogen as part of the national hydrogen infrastructure vision.

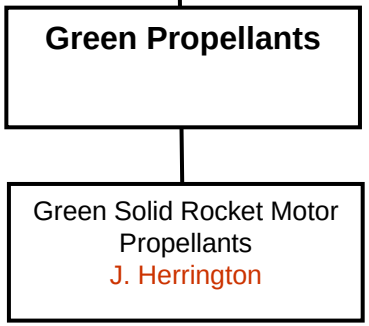
Achievements:

- Site visit and discussions with NREL, March 2006
- International VTC with NASA, NREL and C3P, 4 May 2006
- Developed draft project planning document
- Initiating draft Project Management Plan
- Meeting with C3P partners, June 2006
- Site visit to WSTF, October 2006.

Future Plans:

- Continue review WSTF plans and interface with European (C3P) entities
- Initiating draft Project Management Plan
- Proceed on Phase 1-2 of the Project to construct the initial wind farm at WSTF.

Green Propellants Projects



National Aeronautics and Space Administration (NASA)

Green Solid RM Propellants Project

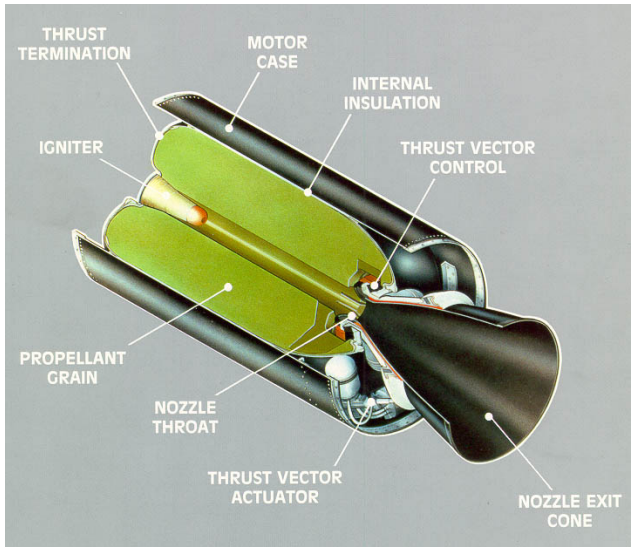
John Herrington

Description:

- Develop less hazardous solid rocket propellants that may be capable of increased thrust/payload capabilities
- Reduce future mission risks associated with environmental hazards and increased capability.

Stakeholders:

- NASA Constellation
- AFSPC
- AFRL



Benefits:

- Eliminates the heavy use of solvents is solid rocket propellant production.
- Possibly increase thrust capacity of Solid Propellants which equates to more onboard fuel capacity or larger payload capability.

Achievements:

- Briefed during the NASA/C3P Pollution Prevention Workshop, Nov. 2006

Future Plans:

- Acquire benefit capability data from AFRL (Dr. Suri)
- Contact MSFC and GRC for potential interest as stakeholders
- Provide programmatic status update to AFSPC for stakeholder consideration.